CDF RunIIb Silicon Detector: Cost & Schedule

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Cost & Schedule boundaries

- Replacing the existing SVXII and L00 detectors.
- Project to be completed in 2005.
- Tevatron will switch to 132ns operation at the time we install the upgraded detectors.
- Estimated down-time for removing the present silicon detector and replace it with the new is ~6-7 months.
- Estimated cost for the Silicon project is 14.4 M$ including FNAL labor and contingency.

  Possible additional contributions coming from Taiwan, Korea and University funds.

Schedule Outline

- Schedule is loaded with information on:
  - M&S cost
  - Source of funding
  - Labor (also non-FNAL labor)
  - Contingency
  - Bases of estimate on cost and labor
  - WBS dictionary
- Schedule is divided in 2 major parts:
  - Stave Construction
  - Mechanical Support
- Schedule is driven by Stave Construction
- Milestones have been identified for every subproject

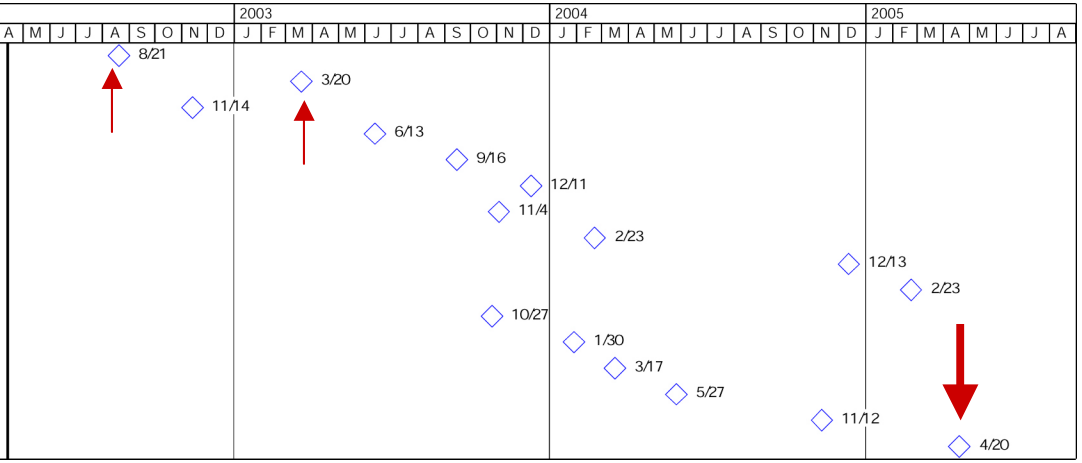
Schedule

ID	WBS	Task Name	Start	Finish	Duration	Cost	U.S. Total	U.S. Est.	Japan	Italy	Labor
1	1.1	Run 2b Silicon Project	Mon 7/2/01	Wed 8/17/05	1027 days	$13,616,229	$8,795,673	$5,682,639	$1,714,264	$345,000	$2,764,512
2	1.1.1	DAQ	Mon 7/2/01	Tue 11/16/04	842 days	$6,099,195	$5,170,053	$3,612,877	$0	$345,000	$584,142
3	1.1.1.1	SVX4 Chips	Mon 7/2/01	Fri 11/21/03	600 days	$1,071,335	$877,044	$615,904	$0	$125,000	$69,291
31	1.1.1.2	Hybrids	Fri 12/14/01	Mon 8/23/04	665 days	$2,038,538	$2,038,538	$1,443,591	$0	$0	$0
70	1.1.1.3	Bus Cables	Fri 12/14/01	Tue 10/21/03	460 days	$61,502	$61,502	$41,001	$0	$0	$0
85	1.1.1.4	Mini Port Card	Wed 10/10/01	Fri 6/4/04	655 days	$627,838	$471,818	$317,414	$0	$0	$156,020
107	1.1.1.5	Junction Port Cards	Tue 4/9/02	Fri 6/4/04	535 days	$331,652	$195,750	$121,500	$0	$0	$135,902
133	1.1.1.6	Junction Cards	Wed 6/5/02	Thu 5/6/04	475 days	$135,934	$84,000	$56,000	$0	$0	$51,934
152	1.1.1.7	Cables	Tue 2/19/02	Thu 4/15/04	535 days	$320,541	$275,201	$183,467	$0	$0	$45,340
183	1.1.1.8	FTMs	Tue 3/19/02	Thu 1/22/04	455 days	$183,707	$117,000	$90,000	$0	$0	$66,707
197	1.1.1.9	DAQ Testing & Readiness	Wed 8/21/02	Thu 12/11/03	325 days	$173,748	$150,000	$100,000	$0	$0	$23,748
201	1.1.1.10	Power Supply system	Tue 4/2/02	Tue 11/16/04	655 days	$772,200	$517,000	$350,000	$0	$220,000	$35,200
214	1.1.1.11	SVT upgrade	Thu 12/11/03	Thu 5/13/04	100 days	$382,200	$382,200	$294,000	$0	$0	$0
217	1.1.2	Sensors	Mon 2/4/02	Fri 7/23/04	615 days	$2,296,246	$694,577	$247,469	$1,550,664	$0	$51,006
243	1.1.3	Construction of Modules, Staves and L0	Mon 9/3/01	Mon 12/13/04	814 days	$2,217,229	$984,650	$626,400	$163,600	$0	$1,068,979
244	1.1.3.1	Beginning of Mechanical Project	Mon 1/7/02	Mon 1/7/02	0 days	$0	$0	$0	$0	$0	$0
245	1.1.3.2	L0 Construction	Mon 9/3/01	Wed 4/21/04	651 days	$518,187	$209,900	$109,900	$163,600	$0	$144,687
271	1.1.3.3	Outer layer modules	Wed 1/30/02	Thu 11/4/04	691 days	$530,439	$161,625	$107,750	$0	$0	$368,814
287	1.1.3.4	Outer layer Staves	Mon 1/7/02	Mon 12/13/04	733 days	$1,168,604	$613,125	$408,750	$0	$0	$555,479
318	1.1.4	Beampipe	Mon 1/7/02	Mon 10/6/03	440 days	$237,771	$224,893	$149,893	$0	$0	$12,878
323	1.1.5	Support Mechanics	Mon 1/7/02	Fri 7/30/04	640 days	$1,575,852	$1,019,000	$746,000	$0	$0	$556,852
365	1.1.6	Cooling and Monitoring	Wed 10/16/02	Thu 12/2/04	526 days	$213,238	$145,000	$95,000	$0	$0	$68,238
376	1.1.7	Final Assembly (Installation and Integration)	Fri 5/24/02	Wed 4/20/05	718 days	$673,723	$307,500	$205,000	$0	$0	$369,443
377	1.1.7.1	Stave Intallation (Outer)	Fri 5/24/02	Wed 2/23/05	678 days	$317,855	$150,000	$100,000	$0	$0	$167,855
392	1.1.7.2	L0 Installation (Inner)	Wed 7/24/02	Fri 11/12/04	574 days	$150,645	$60,000	$40,000	$0	$0	$90,645
402	1.1.7.3	Integration	Mon 8/18/03	Wed 4/20/05	413 days	$205,224	$97,500	$65,000	$0	$0	$110,944
416	1.1.8	Transportation and Installation	Mon 1/3/05	Wed 8/17/05	160 days	$52,974	$0	$0	$0	$0	$52,974
434	1.1.9	Labor contingency	Wed 10/1/03	Thu 12/16/04	300 days	$250,000	$250,000	$0	$0	$0	$0

- The main construction effort will be on modules and staves.
- The key feature of the design (identical modules and staves) allows for a high level of parallelism in the construction
- We are planning to sustain a rate of ~1 stave a day.
- The present schedule has the completed silicon by May 2005

milestones

ID	Task Name	Duration	Start	Finish
1	MILESTONE#1: Prototype Stave available	0 days	Wed 8/21/02	Wed 8/21/02
2	MILESTONE#1*: Contingency Stave available	0 days	Thu 3/20/03	Thu 3/20/03
3	Testing Full Prototype System Complete	0 days	Thu 11/14/02	Thu 11/14/02
4	Testing Full Contingency Prototype System Complete	0 days	Fri 6/13/03	Fri 6/13/03
5	Preproduction Stave: electricals available	0 days	Tue 9/16/03	Tue 9/16/03
6	Testing Full Preproduction System Complete	0 days	Thu 12/11/03	Thu 12/11/03
7	MILESTONE#3: Stave Mechanical Production go-ahead	0 days	Tue 11/4/03	Tue 11/4/03
8	Production Staves Available	0 days	Mon 2/23/04	Mon 2/23/04
9	Stave Production Complete	0 days	Mon 12/13/04	Mon 12/13/04
10	Outer Detector Complete	0 days	Wed 2/23/05	Wed 2/23/05
11	Milestone#2: L0 preproduction module ready	0 days	Mon 10/27/03	Mon 10/27/03
12	L0 Preproduction electrical test complete	0 days	Fri 1/30/04	Fri 1/30/04
13	L0 Production Modules Available	0 days	Wed 3/17/04	Wed 3/17/04
14	L0 Carbon Fiber Support Complete	0 days	Thu 5/27/04	Thu 5/27/04
15	Inner Detector Complete	0 days	Fri 11/12/04	Fri 11/12/04
16	SVX2b Ready for Installation	0 days	Wed 4/20/05	Wed 4/20/05



- First stave prototype by Aug 2002
  - Mech.staves, SVX4 chips (ER), hybrids, bus-cable, miniPC, JPC
  - Exhaustive tests both electrical and mechanical
- We included a second prototype run (contingency) for stave parts, module construction and stave construction.
- There are 7 months between the 1st and the 2nd (Contingency) Prototype level
  - The schedule follows the conservative 2nd round of chips and prototypes
- Production electrical stave starts by Summer 2003
- L0 (L00 style) construction happens in parallel. Not critical path
- Detector complete by May 2005

SVX4 Chip

ID	WBS	Task Name	Start	Finish	Duration	Cost	U.S. Total	U.S. Est.	Japan	Italy	Labor
1	1.1	Run 2b Silicon Project	Mon 7/2/01	Fri 11/21/03	600 days	$1,071,335	$8,795,673	$5,682,639	$1,714,264	$345,000	$2,764,512
2	1.1.1	DAQ	Mon 7/2/01	Fri 11/21/03	600 days	$1,071,335	$5,170,053	$3,612,877	$0	$345,000	$584,142
3	1.1.1.1	SVX4 Chips	Mon 7/2/01	Fri 11/21/03	600 days	$1,071,335	$877,044	$615,904	$0	$125,000	$69,291
4	1.1.1.1.1	1st chip: layout	Mon 7/2/01	Mon 4/1/02	187 days	$135,880	$88,014	$88,014	$0	$25,000	$22,866
5	1.1.1.1.2	1st Chip submission (eng. Run)	Mon 4/1/02	Mon 4/1/02	0 days	$0	$0	$0	$0	$0	$0
6	1.1.1.1.3	1st chip: documentation	Mon 4/1/02	Mon 4/22/02	15 days	$15,000	$15,000	$7,500	$0	$0	$0
7	1.1.1.1.4	1st Chip: manufacturing	Mon 4/1/02	Tue 5/28/02	40 days	$58,000	$58,000	$58,000	$0	$0	$0
8	1.1.1.1.5	1st Chip: postprocessing	Tue 5/28/02	Tue 6/11/02	10 days	$10,000	$10,000	$5,000	$0	$0	$0
9	1.1.1.1.6	1st Chip: engineering evaluation at FNAL	Wed 6/12/02	Wed 7/10/02	20 days	$8,152	$0	$0	$0	$0	$8,152
10	1.1.1.1.7	1st Chip: engineering evaluation at LBL	Tue 6/11/02	Thu 9/5/02	60 days	$27,624	$27,624	$13,812	$0	$0	$0
11	1.1.1.1.8	1st Chip: evaluation	Wed 6/12/02	Thu 10/3/02	80 days	$3,072	$0	$0	$0	$0	$3,072
12	1.1.1.1.9	1st Chip ready for hybrids	Wed 7/10/02	Wed 7/10/02	0 days	$0	$0	$0	$0	$0	$0
13	1.1.1.1.10	2nd Chip: layout	Thu 10/3/02	Thu 10/31/02	20 days	$116,224	$108,072	$54,036	$0	$0	$8,152
14	1.1.1.1.11	2nd Chip: submission (eng. Run)	Thu 10/31/02	Thu 10/31/02	0 days	$0	$0	$0	$0	$0	$0
15	1.1.1.1.12	2nd Chip: manufacturing	Thu 10/31/02	Thu 1/9/03	40 days	$125,000	$125,000	$100,000	$0	$0	$0
16	1.1.1.1.13	2nd Chip: postprocessing	Thu 1/9/03	Thu 1/23/03	10 days	$11,250	$11,250	$7,500	$0	$0	$0
17	1.1.1.1.14	2nd Chip: engineering evaluation at FNAL	Fri 1/24/03	Thu 2/20/03	20 days	$4,076	$0	$0	$0	$0	$4,076
18	1.1.1.1.15	2nd Chip: engineering evaluation at LBL	Thu 1/23/03	Thu 3/13/03	35 days	$12,000	$12,000	$6,000	$0	$0	$0
19	1.1.1.1.16	Setup for production chip testing	Thu 2/20/03	Thu 3/20/03	20 days	$8,958	$5,000	$3,750	$0	$0	$3,958
20	1.1.1.1.17	2nd Chip: evaluation	Fri 1/24/03	Thu 3/20/03	40 days	$1,536	$0	$0	$0	$0	$1,536
21	1.1.1.1.18	2nd Chip ready for hybrids	Thu 2/6/03	Thu 2/6/03	0 days	$0	$0	$0	$0	$0	$0
22	1.1.1.1.19	Production Chip: layout	Thu 3/20/03	Thu 4/17/03	20 days	$69,660	$65,584	$32,792	$0	$0	$4,076
23	1.1.1.1.20	Production chip Submission	Thu 4/17/03	Thu 4/17/03	0 days	$0	$0	$0	$0	$0	$0
24	1.1.1.1.21	Production Chip: manufacturing	Thu 4/17/03	Fri 6/13/03	40 days	$422,500	$322,500	$225,000	$0	$100,000	$0
25	1.1.1.1.22	Production Chip: postprocessing	Fri 6/13/03	Fri 6/27/03	10 days	$20,000	$20,000	$10,000	$0	$0	$0
26	1.1.1.1.23	Production Chip: engineering evaluation at LBL	Fri 6/27/03	Mon 8/4/03	25 days	$9,000	$9,000	$4,500	$0	$0	$0
27	1.1.1.1.24	CDF chips: Test	Tue 7/8/03	Fri 11/21/03	98 days	$13,403	$0	$0	$0	$0	$13,403
28	1.1.1.1.25	CDF chips: 1/2 chips tested	Mon 9/8/03	Mon 9/8/03	0 days	$0	$0	$0	$0	$0	$0
29	1.1.1.1.26	Production Chips ready for hybrids	Mon 8/4/03	Mon 8/4/03	0 days	$0	$0	$0	$0	$0	$0
30	1.1.1.1.27	Chip testing Complete	Fri 11/21/03	Fri 11/21/03	0 days	$0	$0	$0	$0	$0	$0

- Engineering run chips available by end of June 2002
- 2nd engineering run assumed (contingency) in October 2002
  In principle this could be the production run.
- Production submission by April 2003
- Common with D0
- Total CDF cost ~1.0M$ (includes labor and contingency)

Sensors

ID	WBS	Task Name	Start	Finish	Duration	Cost	U.S. Total	U.S. Est.	Japan	Italy	Labor
1	1.1	Run 2b Silicon Project	Mon 7/2/01	Wed 8/17/05	1027 days	$13,616,229	$8,795,673	$5,682,639	$1,714,264	$345,000	$2,764,512
2	1.1.1	DAQ	Mon 7/2/01	Tue 11/16/04	842 days	$6,099,195	$5,170,053	$3,612,877	$0	$345,000	$584,142
217	1.1.2	Sensors	Mon 2/4/02	Fri 7/23/04	615 days	$2,296,246	$694,577	$247,469	$1,550,664	$0	$51,006
218	1.1.2.1	Outer layers	Mon 2/4/02	Fri 7/23/04	615 days	$2,150,566	$655,380	$233,506	$1,466,550	$0	$28,637
219	1.1.2.1.1	Dummy Sensors: layout	Mon 4/1/02	Fri 4/12/02	10 days	$0	$0	$0	$0	$0	$0
220	1.1.2.1.2	Dummy Sensors: manufacturing	Fri 4/12/02	Mon 6/10/02	40 days	$12,750	$12,750	$8,500	$0	$0	$0
221	1.1.2.1.3	Prototype Sensor Layout	Mon 2/4/02	Fri 3/29/02	40 days	$22,369	$0	$0	$0	$0	$22,369
222	1.1.2.1.4	Prototype Sensors: submission	Fri 3/29/02	Fri 3/29/02	0 days	$0	$0	$0	$0	$0	$0
223	1.1.2.1.5	Prototype Sensor manufacturing	Fri 3/29/02	Tue 7/16/02	75 days	$178,420	$16,220	$0	$162,200	$0	$0
224	1.1.2.1.6	Prototype Sensors Available	Tue 7/16/02	Tue 7/16/02	0 days	$0	$0	$0	$0	$0	$0
225	1.1.2.1.7	Sensor final design work	Wed 7/17/02	Tue 8/13/02	20 days	$3,388	$0	$0	$0	$0	$3,388
226	1.1.2.1.8	Prototype Sensor tests	Tue 7/16/02	Wed 10/9/02	60 days	$8,880	$6,000	$4,000	$0	$0	$2,880
227	1.1.2.1.9	Silicon Production Sensor ready to order	Wed 10/9/02	Wed 10/9/02	0 days	$0	$0	$0	$0	$0	$0
228	1.1.2.1.10	Production Sensors manufacturing	Wed 10/9/02	Wed 3/31/04	360 days	$0	$0	$0	$0	$0	$0
229	1.1.2.1.11	Axial sensor order (1st half)	Wed 10/9/02	Wed 10/9/02	0 days	$662,634	$210,633	$75,033	$452,002	$0	$0
230	1.1.2.1.12	Axial sensor order (2nd half)	Mon 10/27/03	Mon 10/27/03	0 days	$635,635	$210,633	$75,033	$425,002	$0	$0
231	1.1.2.1.13	Small Angle Stereo order (1st half)	Wed 10/9/02	Wed 10/9/02	0 days	$626,490	$199,144	$70,940	$427,346	$0	$0
232	1.1.2.1.14	Small Angle Stereo order (2nd half)	Mon 10/27/03	Mon 10/27/03	0 days	$0	$0	$0	$0	$0	$0
233	1.1.2.1.15	Sensor Testing	Thu 2/13/03	Fri 7/23/04	360 days	$0	$0	$0	$0	$0	$0
234	1.1.2.1.16	Production Sensors Available	Wed 2/12/03	Wed 2/12/03	0 days	$0	$0	$0	$0	$0	$0
235	1.1.2.1.17	Production Sensors Complete	Wed 3/31/04	Wed 3/31/04	0 days	$0	$0	$0	$0	$0	$0
236	1.1.2.2	layer L0	Tue 5/28/02	Thu 7/3/03	275 days	$145,680	$39,197	$13,963	$84,114	$0	$22,369
237	1.1.2.2.1	L0 Sensor final design work	Tue 5/28/02	Tue 7/23/02	40 days	$22,369	$0	$0	$0	$0	$22,369
238	1.1.2.2.2	L0 Production sensor order	Wed 10/9/02	Wed 10/9/02	0 days	$0	$0	$0	$0	$0	$0
239	1.1.2.2.3	L0 Sensor Production	Wed 5/7/03	Thu 6/5/03	20 days	$123,311	$39,197	$13,963	$84,114	$0	$0
240	1.1.2.2.4	Sensor Testing	Fri 6/6/03	Thu 7/3/03	20 days	$0	$0	$0	$0	$0	$0
241	1.1.2.2.5	L0 Sensors Available	Thu 7/3/03	Thu 7/3/03	0 days	$0	$0	$0	$0	$0	$0
242	1.1.2.2.6	L0 Sensors Complete	Thu 6/5/03	Thu 6/5/03	0 days	$0	$0	$0	$0	$0	$0

- Prototype order already submitted (Apr 1 2002)
- Production order to go out by October 2002 but could be delayed by a few months if needed without interfering with the schedule (but advantageous to procure all silicon in advance)
- Production detectors should arrive between Feb 2003 and March 2004.
- Expecting a minimum production rate of 200 detector/month
- Total sensor cost is ~2.3M$ (includes 30% contingency and 20% spares)

Hybrid

ID	WBS	Task Name	Start	Finish	Duration	Cost	U.S. Total	U.S. Est.	Japan	Italy	Labor
1	1.1	Run 2b Silicon Project	Mon 7/2/01	Wed 8/17/05	1027 days	$13,616,229	$8,795,673	$5,682,639	$1,714,264	$345,000	$2,764,512
2	1.1.1	DAQ	Mon 7/2/01	Tue 11/16/04	842 days	$6,099,195	$5,170,053	$3,612,877	$0	$345,000	$584,142
3	1.1.1.1	SVX4 Chips	Mon 7/2/01	Fri 11/21/03	600 days	$1,071,335	$877,044	$615,904	$0	$125,000	$69,291
31	1.1.1.2	Hybrids	Fri 12/14/01	Mon 8/23/04	665 days	$2,038,538	$2,038,538	$1,443,591	$0	$0	$0
32	1.1.1.2.1	Outer layers	Fri 12/14/01	Mon 8/23/04	665 days	$1,752,946	$1,752,946	$1,253,197	$0	$0	$0
33	1.1.1.2.1.1	Hybrid #1: Layout	Fri 12/14/01	Mon 4/15/02	80 days	$0	$0	$0	$0	$0	$0
34	1.1.1.2.1.2	Hybrid#1: Submission	Mon 4/15/02	Mon 4/15/02	0 days	$0	$0	$0	$0	$0	$0
35	1.1.1.2.1.3	Hybrid #1: manufacturing	Mon 4/15/02	Tue 6/25/02	50 days	$114,391	$114,391	$87,993	$0	$0	$0
36	1.1.1.2.1.4	Hybrid #1 ready for chips	Wed 7/10/02	Wed 7/10/02	0 days	$0	$0	$0	$0	$0	$0
37	1.1.1.2.1.5	Hybrid #1 available	Wed 7/24/02	Wed 7/24/02	0 days	$0	$0	$0	$0	$0	$0
38	1.1.1.2.1.6	Hybrid #1: Evaluation	Thu 7/25/02	Thu 10/17/02	60 days	$0	$0	$0	$0	$0	$0
39	1.1.1.2.1.7	Setup Hybrid test stand	Thu 7/11/02	Thu 5/1/03	200 days	$70,491	$70,491	$46,994	$0	$0	$0
40	1.1.1.2.1.8	Hybrid #2: Layout	Fri 9/6/02	Thu 10/31/02	40 days	$0	$0	$0	$0	$0	$0
41	1.1.1.2.1.9	Hybrid #2: Submission	Thu 10/31/02	Thu 10/31/02	0 days	$0	$0	$0	$0	$0	$0
42	1.1.1.2.1.10	Hybrid #2: manufacturing	Thu 10/31/02	Thu 1/23/03	50 days	$114,391	$114,391	$0	$0	$0	$0
43	1.1.1.2.1.11	Hybrid #2 ready for chips	Thu 2/6/03	Thu 2/6/03	0 days	$0	$0	$0	$0	$0	$0
44	1.1.1.2.1.12	Hybrid #2 available	Thu 2/20/03	Thu 2/20/03	0 days	$0	$0	$0	$0	$0	$0
45	1.1.1.2.1.13	Hybrid #2: Evaluation	Fri 2/21/03	Thu 5/15/03	60 days	$0	$0	$0	$0	$0	$0
46	1.1.1.2.1.14	Preproduction hybrid: Layout	Fri 2/21/03	Thu 4/17/03	40 days	$0	$0	$0	$0	$0	$0
47	1.1.1.2.1.15	Preproduction Hybrid: Submission	Thu 4/17/03	Thu 4/17/03	0 days	$0	$0	$0	$0	$0	$0
48	1.1.1.2.1.16	Preproduction hybrid: manufacturing	Thu 4/17/03	Mon 7/14/03	60 days	$197,343	$197,343	$151,802	$0	$0	$0
49	1.1.1.2.1.17	Preproduction Hybrid ready for chips	Fri 6/27/03	Fri 6/27/03	0 days	$0	$0	$0	$0	$0	$0
50	1.1.1.2.1.18	Preproduction Hybrid Available	Mon 8/18/03	Mon 8/18/03	0 days	$0	$0	$0	$0	$0	$0
51	1.1.1.2.1.19	Preproduction Hybrid complete	Thu 1/8/04	Thu 1/8/04	0 days	$0	$0	$0	$0	$0	$0
52	1.1.1.2.1.20	Preproduction Hybrid: Evaluation	Tue 8/19/03	Tue 10/14/03	40 days	$0	$0	$0	$0	$0	$0
53	1.1.1.2.1.21	Production Hybrid: layout	Tue 8/19/03	Tue 10/14/03	40 days	$0	$0	$0	$0	$0	$0
54	1.1.1.2.1.22	Production Hybrid Go-ahead	Tue 10/14/03	Tue 10/14/03	0 days	$0	$0	$0	$0	$0	$0
55	1.1.1.2.1.23	Production Hybrid: manufacturing	Tue 10/14/03	Thu 2/19/04	80 days	$1,256,330	$1,256,330	$966,408	$0	$0	$0
56	1.1.1.2.1.24	Production Hybrids Available	Thu 1/22/04	Thu 1/22/04	0 days	$0	$0	$0	$0	$0	$0
57	1.1.1.2.1.25	Production Hybrid: testing	Fri 1/23/04	Mon 8/23/04	150 days	$0	$0	$0	$0	$0	$0
58	1.1.1.2.1.26	Hybrid Production Complete	Mon 8/23/04	Mon 8/23/04	0 days	$0	$0	$0	$0	$0	$0
59	1.1.1.2.2	Layer 0	Tue 4/16/02	Thu 4/8/04	490 days	$285,592	$285,592	$190,394	$0	$0	$0
60	1.1.1.2.2.1	Prototype#1 L0 hybrid: Layout	Tue 4/16/02	Wed 7/10/02	60 days	$0	$0	$0	$0	$0	$0
61	1.1.1.2.2.2	Prototype#1 L0 hybrid: Submission	Wed 7/10/02	Wed 7/10/02	0 days	$0	$0	$0	$0	$0	$0
62	1.1.1.2.2.3	Prototype#1 L0 hybrid: manufacturing	Thu 2/20/03	Thu 5/1/03	50 days	$142,796	$142,796	$95,197	$0	$0	$0
63	1.1.1.2.2.4	Prototype#1 L0 hybrid Available	Fri 5/30/03	Fri 5/30/03	0 days	$0	$0	$0	$0	$0	$0
64	1.1.1.2.2.5	Prototype#1 L0 hybrid: evaluation and final design	Mon 6/2/03	Tue 10/21/03	100 days	$0	$0	$0	$0	$0	$0
65	1.1.1.2.2.6	Production L0 Hybrid: final layout	Wed 9/24/03	Tue 10/21/03	20 days	$0	$0	$0	$0	$0	$0
66	1.1.1.2.2.7	Production L0 Hybrid Submission	Tue 10/21/03	Tue 10/21/03	0 days	$0	$0	$0	$0	$0	$0
67	1.1.1.2.2.8	Production L0 hybrid: manufacturing	Tue 10/21/03	Thu 1/15/04	50 days	$142,796	$142,796	$95,197	$0	$0	$0
68	1.1.1.2.2.9	Production L0 hybrid available	Thu 2/12/04	Thu 2/12/04	0 days	$0	$0	$0	$0	$0	$0
69	1.1.1.2.2.10	Production L0 hybrid complete	Thu 4/8/04	Thu 4/8/04	0 days	$0	$0	$0	$0	$0	$0

- 2 prototype runs + pre-production run in the schedule to minimize risks
- Same technology already successfully used for the L00 and other projects
- 94% of production is the same 4-chip hybrid
- A rate of 40 hybrids/week (loaded and tested) is expected in order to match the stave construction and considered comfortably achievable
- Total cost ~2.0M$

Mini Port Card

ID	WBS	Task Name	Start	Finish	Duration	Cost	U.S. Total	U.S. Est.	Japan	Italy	Labor
1	1.1	Run 2b Silicon Project	Mon 7/2/01	Wed 8/17/05	1027 days	$13,616,229	$8,795,673	$5,682,639	$1,714,264	$345,000	$2,764,512
2	1.1.1	DAQ	Mon 7/2/01	Tue 11/16/04	842 days	$6,099,195	$5,170,053	$3,612,877	$0	$345,000	$584,142
3	1.1.1.1	SVX4 Chips	Mon 7/2/01	Fri 11/21/03	600 days	$1,071,335	$877,044	$615,904	$0	$125,000	$69,291
31	1.1.1.2	Hybrids	Fri 12/14/01	Mon 8/23/04	665 days	$2,038,538	$2,038,538	$1,443,591	$0	$0	$0
70	1.1.1.3	Bus Cables	Fri 12/14/01	Tue 10/21/03	460 days	$61,502	$61,502	$41,001	$0	$0	$0
85	1.1.1.4	Mini Port Card	Wed 10/10/01	Fri 6/4/04	655 days	$627,838	$471,818	$317,414	$0	$0	$156,020
86	1.1.1.4.1	Prototype#1 MPC: specs, design and layout	Wed 10/10/01	Mon 4/8/02	120 days	$47,496	$0	$0	$0	$0	$47,496
87	1.1.1.4.2	Prototype#1 MPC submission	Mon 4/8/02	Mon 4/8/02	0 days	$0	$0	$0	$0	$0	$0
88	1.1.1.4.3	Prototype#1 MPC: manufacturing	Mon 4/8/02	Tue 6/18/02	50 days	$59,179	$59,179	$45,522	$0	$0	$0
89	1.1.1.4.4	Prototype#1 MPC Available	Wed 7/17/02	Wed 7/17/02	0 days	$0	$0	$0	$0	$0	$0
90	1.1.1.4.5	Prototype#1 MPC: assembly and evaluation	Wed 6/19/02	Wed 8/14/02	40 days	$11,756	$0	$0	$0	$0	$11,756
91	1.1.1.4.6	Prototype#2 MPC: design and layout	Fri 9/27/02	Thu 10/24/02	20 days	$7,916	$0	$0	$0	$0	$7,916
92	1.1.1.4.7	Prototype#2 MPC Submission	Thu 10/24/02	Thu 10/24/02	0 days	$0	$0	$0	$0	$0	$0
93	1.1.1.4.8	Prototype#2 MPC: manufacturing	Thu 10/24/02	Thu 1/16/03	50 days	$59,179	$59,179	$0	$0	$0	$0
94	1.1.1.4.9	Prototype#2 MPC Available	Thu 2/13/03	Thu 2/13/03	0 days	$0	$0	$0	$0	$0	$0
95	1.1.1.4.10	Prototype#2 MPC: assembly and evaluation	Fri 2/14/03	Thu 4/10/03	40 days	$11,756	$0	$0	$0	$0	$11,756
96	1.1.1.4.11	Preproduction MPC: design and layout	Fri 2/14/03	Thu 4/10/03	40 days	$15,832	$0	$0	$0	$0	$15,832
97	1.1.1.4.12	Preproduction MPC Submission	Thu 4/10/03	Thu 4/10/03	0 days	$0	$0	$0	$0	$0	$0
98	1.1.1.4.13	Preproduction MPC: manufacturing	Thu 4/10/03	Fri 6/20/03	50 days	$82,826	$82,826	$63,712	$0	$0	$0
99	1.1.1.4.14	Preproduction MPC assembly and evaluation	Mon 6/23/03	Mon 8/18/03	40 days	$15,596	$0	$0	$0	$0	$15,596
100	1.1.1.4.15	Preproduction MPC Available	Mon 7/21/03	Mon 7/21/03	0 days	$0	$0	$0	$0	$0	$0
101	1.1.1.4.16	Production MPC: design and layout	Wed 9/10/03	Tue 10/7/03	20 days	$6,678	$0	$0	$0	$0	$6,678
102	1.1.1.4.17	Production MPC go ahead	Tue 10/7/03	Tue 10/7/03	0 days	$0	$0	$0	$0	$0	$0
103	1.1.1.4.18	Production MPC: manufacturing	Tue 10/7/03	Thu 2/12/04	80 days	$270,634	$270,634	$208,180	$0	$0	$0
104	1.1.1.4.19	Production MPC available	Thu 1/15/04	Thu 1/15/04	0 days	$0	$0	$0	$0	$0	$0
105	1.1.1.4.20	Production MPC: assembly and evaluation	Fri 1/16/04	Fri 6/4/04	100 days	$38,990	$0	$0	$0	$0	$38,990
106	1.1.1.4.21	Production MPC complete	Fri 6/4/04	Fri 6/4/04	0 days	$0	$0	$0	$0	$0	$0

- 1 mini port card per stave
- 2 prototype runs + pre-production run in the schedule to minimize risks
- Same technology as the hybrid
- Total cost ~0.65 M$

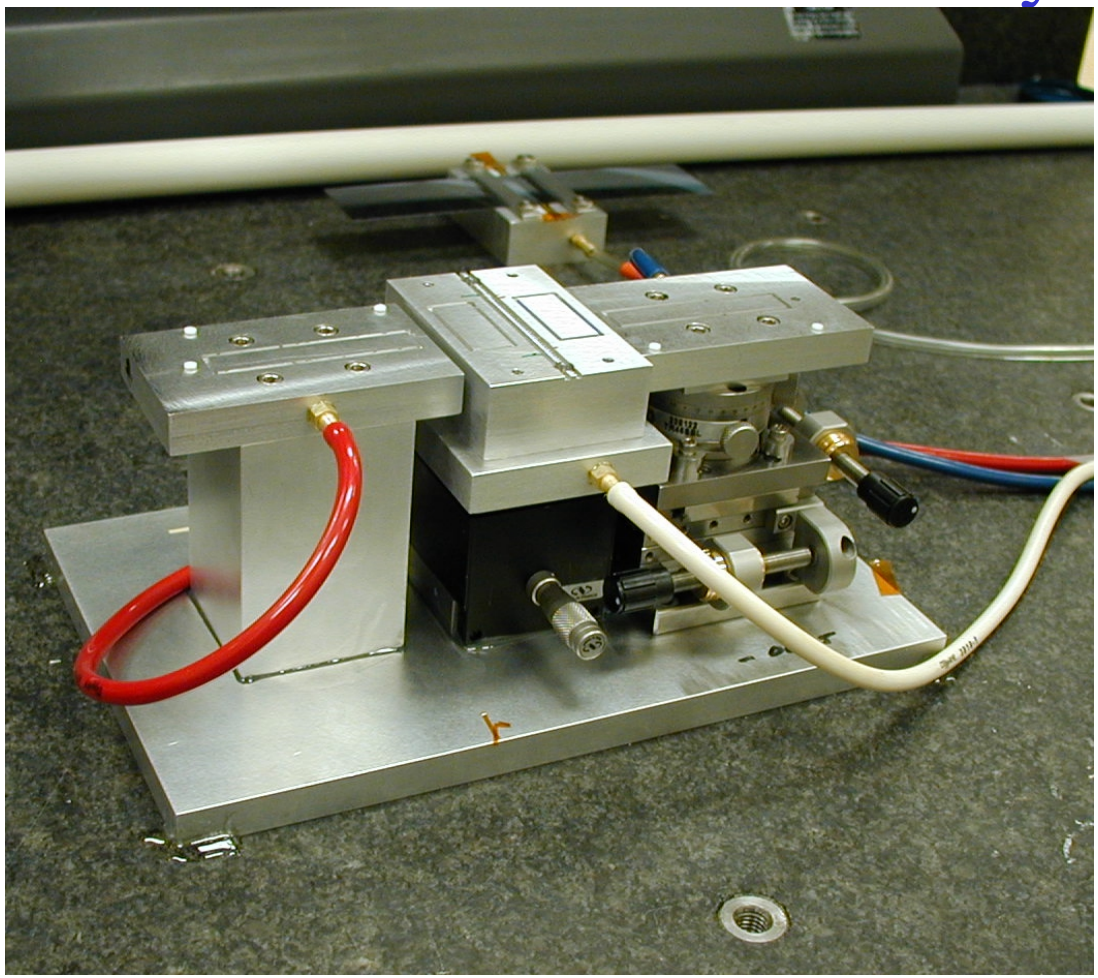
Module Production Schedule

ID	WBS	Task Name	Start	Finish	Duration	Cost	U.S. Total	U.S. Est.	Japan	Italy	Labor
1	1.1	Run 2b Silicon Project	Mon 7/2/01	Wed 8/17/05	1027 days	$13,616,229	$8,795,673	$5,682,639	$1,714,264	$345,000	$2,764,512
2	1.1.1	DAQ	Mon 7/2/01	Tue 11/16/04	842 days	$6,099,195	$5,170,053	$3,612,877	$0	$345,000	$584,142
217	1.1.2	Sensors	Mon 2/4/02	Fri 7/23/04	615 days	$2,296,246	$694,577	$247,469	$1,550,664	$0	$51,006
243	1.1.3	Construction of Modules, Staves and LO	Mon 9/3/01	Mon 12/13/04	814 days	$2,217,229	$984,650	$626,400	$163,600	$0	$1,068,979
244	1.1.3.1	Beginning of Mechanical Project	Mon 1/7/02	Mon 1/7/02	0 days	$0	$0	$0	$0	$0	$0
245	1.1.3.2	LO Construction	Mon 9/3/01	Wed 4/21/04	651 days	$518,187	$209,900	$109,900	$163,600	$0	$144,687
271	1.1.3.3	Outer layer modules	Wed 1/30/02	Thu 11/4/04	691 days	$530,439	$161,625	$107,750	$0	$0	$368,814
272	1.1.3.3.1	Prototype Module: fixtures design	Wed 1/30/02	Tue 4/23/02	60 days	$44,330	$0	$0	$0	$0	$44,330
273	1.1.3.3.2	Prototype Module: material and fixtures	Tue 4/23/02	Wed 6/19/02	40 days	$33,750	$33,750	$22,500	$0	$0	$0
274	1.1.3.3.3	Prototype Module: Assembling	Thu 7/25/02	Thu 10/17/02	60 days	$37,975	$0	$0	$0	$0	$37,975
275	1.1.3.3.4	Prototype modules available	Wed 8/7/02	Wed 8/7/02	0 days	$0	$0	$0	$0	$0	$0
276	1.1.3.3.5	Contingency Module: Assembling	Fri 2/21/03	Thu 5/15/03	60 days	$0	$0	$0	$0	$0	$0
277	1.1.3.3.6	Contingency modules available	Thu 3/6/03	Thu 3/6/03	0 days	$0	$0	$0	$0	$0	$0
278	1.1.3.3.7	Preproduction Module: fixtures design	Fri 3/7/03	Thu 4/17/03	30 days	$22,165	$0	$0	$0	$0	$22,165
279	1.1.3.3.8	Preproduction Module: material and fixtures	Thu 4/17/03	Fri 6/13/03	40 days	$57,750	$57,750	$38,500	$0	$0	$0
280	1.1.3.3.9	Preproduction module: Assembling	Tue 8/19/03	Thu 1/22/04	100 days	$80,390	$0	$0	$0	$0	$80,390
281	1.1.3.3.10	Preproduction modules available	Tue 9/2/03	Tue 9/2/03	0 days	$0	$0	$0	$0	$0	$0
282	1.1.3.3.11	Production Module: contingency fixtures design	Wed 9/3/03	Tue 9/30/03	20 days	$14,777	$0	$0	$0	$0	$14,777
283	1.1.3.3.12	Production modules: material and fixtures	Tue 9/30/03	Tue 11/25/03	40 days	$70,125	$70,125	$46,750	$0	$0	$0
284	1.1.3.3.13	Production Modules: Assembling	Tue 1/27/04	Thu 11/4/04	200 days	$169,176	$0	$0	$0	$0	$169,176
285	1.1.3.3.14	Production modules available	Mon 2/9/04	Mon 2/9/04	0 days	$0	$0	$0	$0	$0	$0
286	1.1.3.3.15	Module Production complete	Thu 11/4/04	Thu 11/4/04	0 days	$0	$0	$0	$0	$0	$0

Module construction

- Sensors are glued together “head-on” on a special fixture under the CMM. Hybrid and pitch adapter is also added.
  - It takes ~ 2hr to align and glue all parts.
  - Alignment precision on strips ~2-4um
  - Glue will take >12 hr to cure.
  - Fixture has a removable center block for glue curing.
- Need 6 modules/day on production
  - 2 technicians on 2 CMMs
- Above operation is the same used for L00 construction
- Number of production hours: 1,200*2 = 2,400 hr
- Total number of hours allocated including support: 4,960 hr
- Total cost ~ 0.5 M$

Fixture for Module assembly



- Fixture for module assembly is similar to L00

Module Bonding

- Number of bonds per module is ~ 1,600 positioned in 3 rows
  - It will take ~ 1hr per module
  - Need to sustain a rate of 6 modules/day
  - 1 dedicated machine + 1 dedicated operator
- Testing and repair will follow
  - Testing time is very short (~ 20 m mostly setup time)
  - Amount of repair needed is hopefully less of an issue with respect to the SVXII work (single sided silicon detectors)
  - No burn-in of modules
- Modules are stored, ready for being installed onto staves
- Machine downtime is considered in the operator inefficiency

Stave Production Schedule

ID	WBS	Task Name	Start	Finish	Duration	Cost	U.S. Total	U.S. Est.	Japan	Italy	Labor
1	1.1	Run 2b Silicon Project	Mon 7/2/01	Wed 8/17/05	1027 days	$13,616,229	$8,795,673	$5,682,639	$1,714,264	$345,000	$2,764,512
2	1.1.1	DAQ	Mon 7/2/01	Tue 11/16/04	842 days	$6,099,195	$5,170,053	$3,612,877	$0	$345,000	$584,142
217	1.1.2	Sensors	Mon 2/4/02	Fri 7/23/04	615 days	$2,296,246	$694,577	$247,469	$1,550,664	$0	$51,006
243	1.1.3	Construction of Modules, Staves and LO	Mon 9/3/01	Mon 12/13/04	814 days	$2,217,229	$984,650	$626,400	$163,600	$0	$1,068,979
244	1.1.3.1	Beginning of Mechanical Project	Mon 1/7/02	Mon 1/7/02	0 days	$0	$0	$0	$0	$0	$0
245	1.1.3.2	LO Construction	Mon 9/3/01	Wed 4/21/04	651 days	$518,187	$209,900	$109,900	$163,600	$0	$144,687
271	1.1.3.3	Outer layer modules	Wed 1/30/02	Thu 11/4/04	691 days	$530,439	$161,625	$107,750	$0	$0	$368,814
287	1.1.3.4	Outer layer Staves	Mon 1/7/02	Mon 12/13/04	733 days	$1,168,604	$613,125	$408,750	$0	$0	$555,479
288	1.1.3.4.1	Prototype stave :Structural and cooling R&D	Mon 1/7/02	Fri 4/26/02	80 days	$100,074	$30,000	$20,000	$0	$0	$70,074
289	1.1.3.4.2	Prototype Stave Design complete	Fri 4/26/02	Fri 4/26/02	0 days	$0	$0	$0	$0	$0	$0
290	1.1.3.4.3	Prototype Stave: material and fixtures	Fri 4/26/02	Mon 6/10/02	30 days	$99,000	$99,000	$66,000	$0	$0	$0
291	1.1.3.4.4	Prototype Stave: mechanical construction	Tue 6/11/02	Tue 8/6/02	40 days	$21,948	$0	$0	$0	$0	$21,948
292	1.1.3.4.5	Prototype Stave: mechanicals available	Tue 7/9/02	Tue 7/9/02	0 days	$0	$0	$0	$0	$0	$0
293	1.1.3.4.6	Prototype Stave: mechanical testing	Wed 7/10/02	Wed 10/30/02	80 days	$25,336	$0	$0	$0	$0	$25,336
294	1.1.3.4.7	Prototype Stave: electrical assembly	Thu 8/8/02	Thu 10/3/02	40 days	$29,976	$0	$0	$0	$0	$29,976
295	1.1.3.4.8	Prototype Stave: electrical testing	Thu 8/15/02	Thu 11/14/02	65 days	$10,394	$0	$0	$0	$0	$10,394
296	1.1.3.4.9	MILESTONE #1: Prototype Stave available	Wed 8/21/02	Wed 8/21/02	0 days	$0	$0	$0	$0	$0	$0
297	1.1.3.4.10	Contingency Stave: electrical assembly	Fri 3/7/03	Thu 5/1/03	40 days	$0	$0	$0	$0	$0	$0
298	1.1.3.4.11	Contingency Stave: electrical testing	Fri 3/14/03	Fri 6/13/03	65 days	$0	$0	$0	$0	$0	$0
299	1.1.3.4.12	MILESTONE #1*: Contingency Stave available	Thu 3/20/03	Thu 3/20/03	0 days	$0	$0	$0	$0	$0	$0
300	1.1.3.4.13	Production Stave: final design	Thu 10/31/02	Wed 1/22/03	50 days	$35,096	$0	$0	$0	$0	$35,096
301	1.1.3.4.14	Production Stave: material and fixtures	Wed 1/22/03	Wed 3/19/03	40 days	$415,125	$415,125	$276,750	$0	$0	$0
302	1.1.3.4.15	Preproduction Stave: mechanical construction	Mon 6/2/03	Mon 7/28/03	40 days	$26,588	$0	$0	$0	$0	$26,588
303	1.1.3.4.16	Preproduction Stave: mechanicals available	Fri 6/13/03	Fri 6/13/03	0 days	$0	$0	$0	$0	$0	$0
304	1.1.3.4.17	Preproduction Stave: mechanical testing	Mon 6/16/03	Mon 7/14/03	20 days	$6,334	$0	$0	$0	$0	$6,334
305	1.1.3.4.18	Preproduction Stave: electrical assembly	Wed 9/3/03	Thu 12/11/03	70 days	$52,213	$0	$0	$0	$0	$52,213
306	1.1.3.4.19	Preproduction Stave: electricals available	Tue 9/16/03	Tue 9/16/03	0 days	$0	$0	$0	$0	$0	$0
307	1.1.3.4.20	Preproduction Stave: electrical testing	Wed 9/10/03	Tue 11/4/03	40 days	$6,960	$0	$0	$0	$0	$6,960
308	1.1.3.4.21	Evaluation of preproduction staves	Wed 9/10/03	Tue 11/4/03	40 days	$21,384	$0	$0	$0	$0	$21,384
309	1.1.3.4.22	MILESTONE #3: Stave Production go-ahead	Tue 11/4/03	Tue 11/4/03	0 days	$0	$0	$0	$0	$0	$0
310	1.1.3.4.23	Production Stave: modification to the final design	Wed 9/10/03	Tue 11/4/03	40 days	$21,301	$0	$0	$0	$0	$21,301
311	1.1.3.4.24	Production Stave: contingency material and fixtures	Tue 11/4/03	Thu 1/15/04	40 days	$69,000	$69,000	$46,000	$0	$0	$0
312	1.1.3.4.25	Production Stave: mechanical construction	Fri 1/16/04	Thu 5/6/04	80 days	$48,536	$0	$0	$0	$0	$48,536
313	1.1.3.4.26	Production Stave: mechanicals available	Thu 1/29/04	Thu 1/29/04	0 days	$0	$0	$0	$0	$0	$0
314	1.1.3.4.27	Production Stave: electrical assembly	Tue 2/10/04	Thu 11/18/04	200 days	$144,540	$0	$0	$0	$0	$144,540
315	1.1.3.4.28	Production Stave: electrical testing	Tue 2/17/04	Mon 11/29/04	200 days	$34,800	$0	$0	$0	$0	$34,800
316	1.1.3.4.29	Production Staves Available	Mon 2/23/04	Mon 2/23/04	0 days	$0	$0	$0	$0	$0	$0
317	1.1.3.4.30	Stave Production Complete	Mon 12/13/04	Mon 12/13/04	0 days	$0	$0	$0	$0	$0	$0

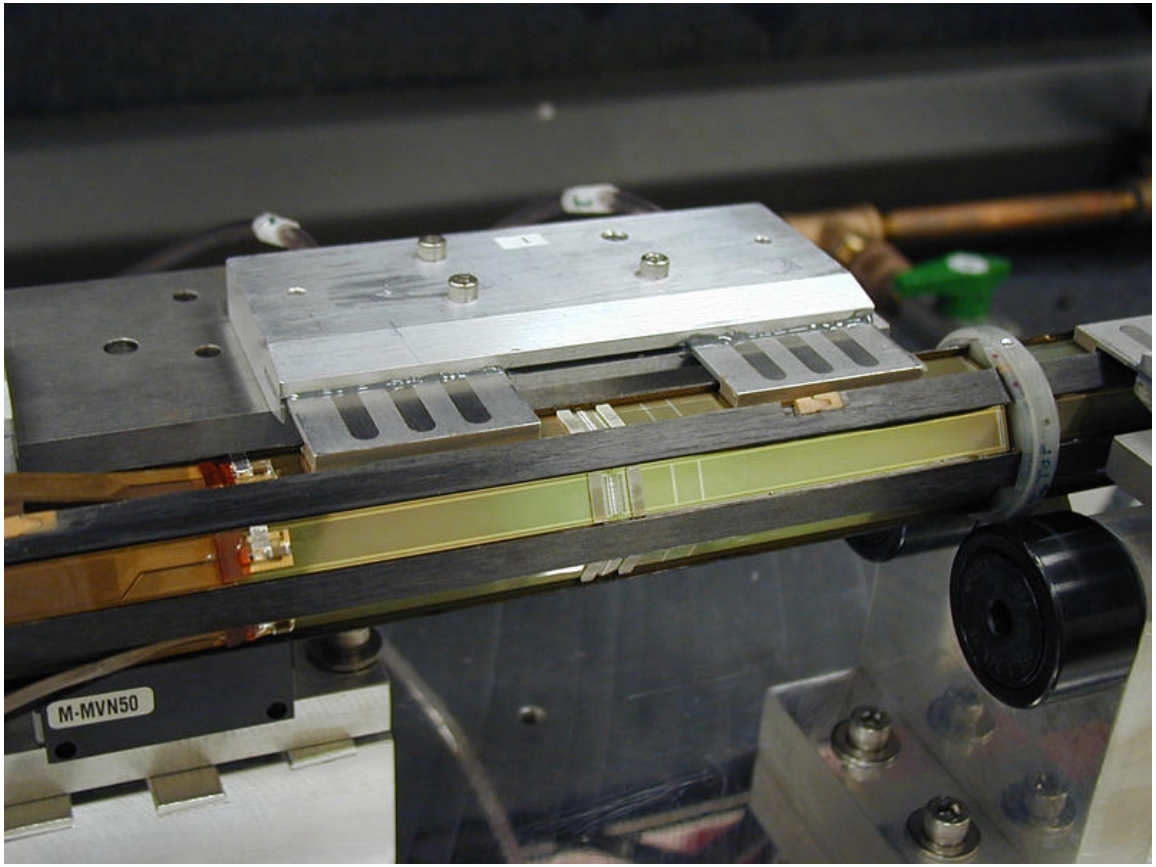
Stave mechanical construction

- Done in advance of module/stave assembly production.
- Major steps are:
  - Prepare and cut to size the CF skin (K13C2U) (in advance)
  - Prepare other parts (mounting features, foam pieces, peek tubing etc.) (in advance)
  - Glue the bus cable to it on a fixture. This operation does not require a CMM and take less then 2 hr.
  - On a mold parts go together and glued
- It takes 2 hr/stave and we will have 3 molds.
- 3 mechanical staves/day during production
- 2 technicians required during production
- Number of hours in production: 240*4 = 960 hr.
- Total number of hours allocated including support: 1,920 hr

Stave Electrical Assembly

- Main steps are:
  - Mechanical stave is put on a fixture referenced via the mounting features of the stave
  - 3 modules are aligned under the CMM and moved under vacuum over the stave
  - Glue is applied and modules are aligned to the fixture (~5um axial).
  - mini port card is positioned and glued (axial side only)
  - Repeat for the stereo side (stereo to axial alignment ~15um)
  - Fold and glue the wing cable (from mini-PC to the stereo side)
- Rate needed is 1 stave/day
- Estimated time required is ~3 hr. per side of stave.
- Number of hours in production: 200*6 = 1,200 hr.
- Total number of hours allocated including support: 4,000 hr
- Stave total cost ~ 1.1M$

Installing modules on Stave Fixture

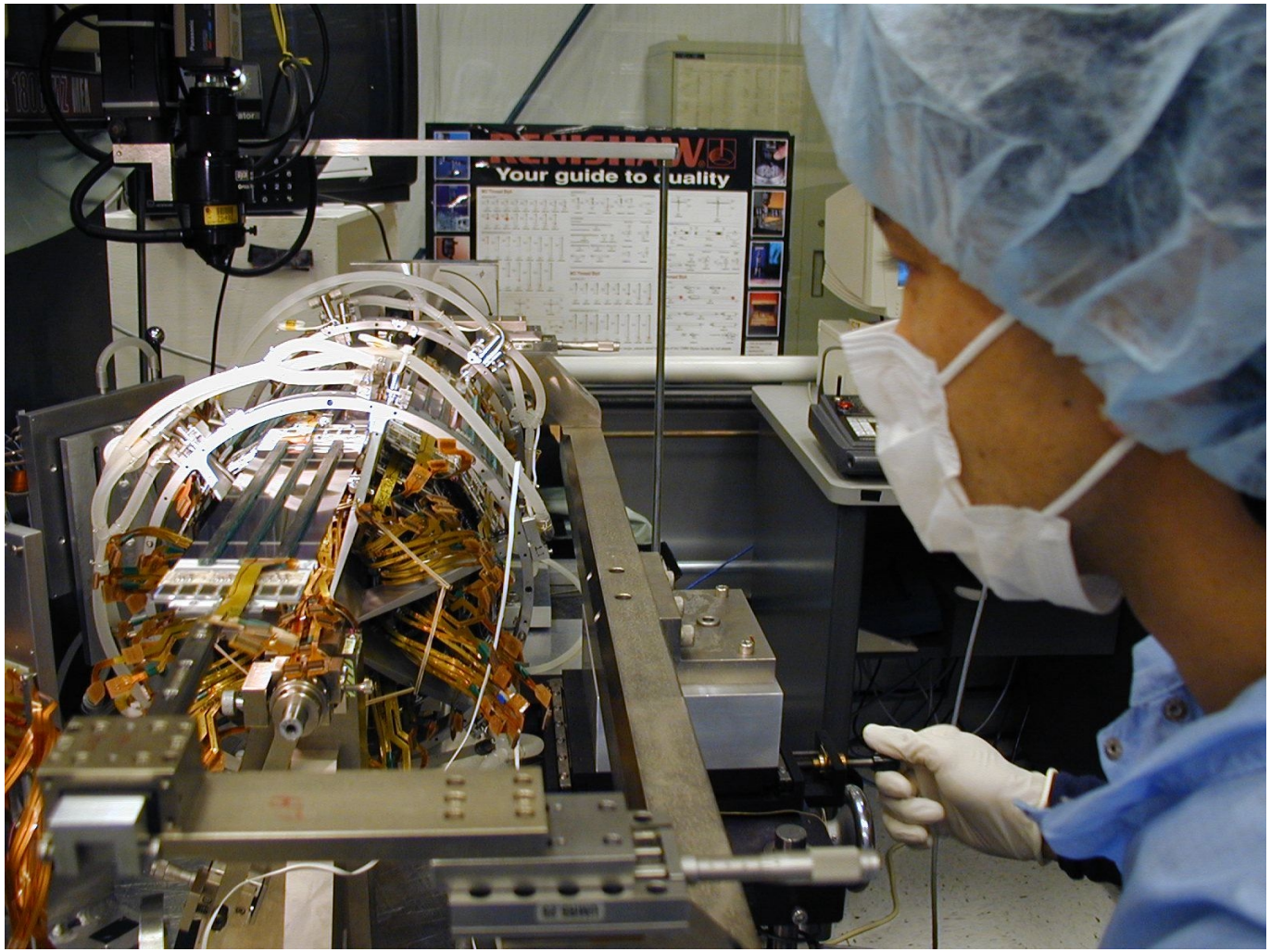


- We are envisioning a similar concept (above used for L00)

Stave Installation

- Main steps are:
  - Align bulk-heads
  - Inner screen is glued
  - We will have a fixture that allows to grab a stave and insert it through the outer bulk-head and engage to the precision position pins on the bulk-head itself.
  - Under the CMM, position adjustments are performed and stave locked in place
- Stave installation and testing needs to be done efficiently in parallel to stave construction
- Estimated time required is 2.0 hr/stave
- Number of hours in production: 180*2.0 = 360 hr.
- Total number of hours allocated including support: 2,820 hr
- Fixture cost ~ 0.15 M$

Stave installation



- Concept similar to what used for SVXII (above in picture)

Stave Bonding

- Need the working area of the K&S 8090
- Bonds are:
  - hybrids to the bus cable (axial and stereo)
  - Bus cable to mini-PC (axial side only)
  - Bus cable to mini-PC wing (stereo side only)
- Estimated time is 4 hr/stave
- There is enough time on this machine to pick up part of the module bonding (~1/2 day) and repair
- 1 dedicated operator and 1 machine assigned to this task

Electrical Testing

- Main testing steps:
  - Chips are tested on wafer
  - Hybrids are tested and burnt-in
  - Hybrids are received and re-tested at SiDet
  - Module are tested and repaired
  - Staves are tested and burnt-in
  - Staves are installed and tested
- Need 3 testing stations + 1 burn-in station
- Need 5 physicists and ~3 g.s. + some technical support personnel
- The above crew will cover all testing need at SiDet

Status of the Project

- SVX4 chips have been submitted. Chips are expected back at the end of May 2002
- Hybrid prototype have been submitted
- MPC prototype have been submitted
- Bus cable prototype have been submitted
- JPC prototype already in hand
- Cables and DAQ already in hand
- CF and G-10 Bulk-head prototypes already made
- Prototype fixture for sensors to sensor alignment already made
- Most of the Prototype fixtures for stave mechanical construction already made

Schedule Contingency

- We built schedule contingency by:

  Increasing the number of submissions for critical parts

  - > Some critical parts such as the hybrids and the MPC have 4 submissions (prototype#1, prototype#2, pre-production and production).
  - > SVX4 chips have 3 submissions (ER1, ER2 and production)

  – We assume that we need to go through all of them for all the critical parts before committing to production.

  – The above yields an intrinsic contingency of 7 months.

  Contingency on the critical tasks such as module construction, stave construction, assembly and installation is built-in.

  – Our construction rate of 6 modules/day and 1 stave/day should be comfortably achievable.

Cost Contingency

Added 100% contingency on all items where we still need a better understanding of our needs

Added 50% contingency on all items for which we don't have a quote or a layout.

Added 30% contingency on all items for which we already have a quote and a layout.

We added contingency to all foreign contributions

We added indirect cost to all foreign contributions

We costed all "contingency" submissions.

Labor Counting and Contingency

Base of estimate for the Labor:

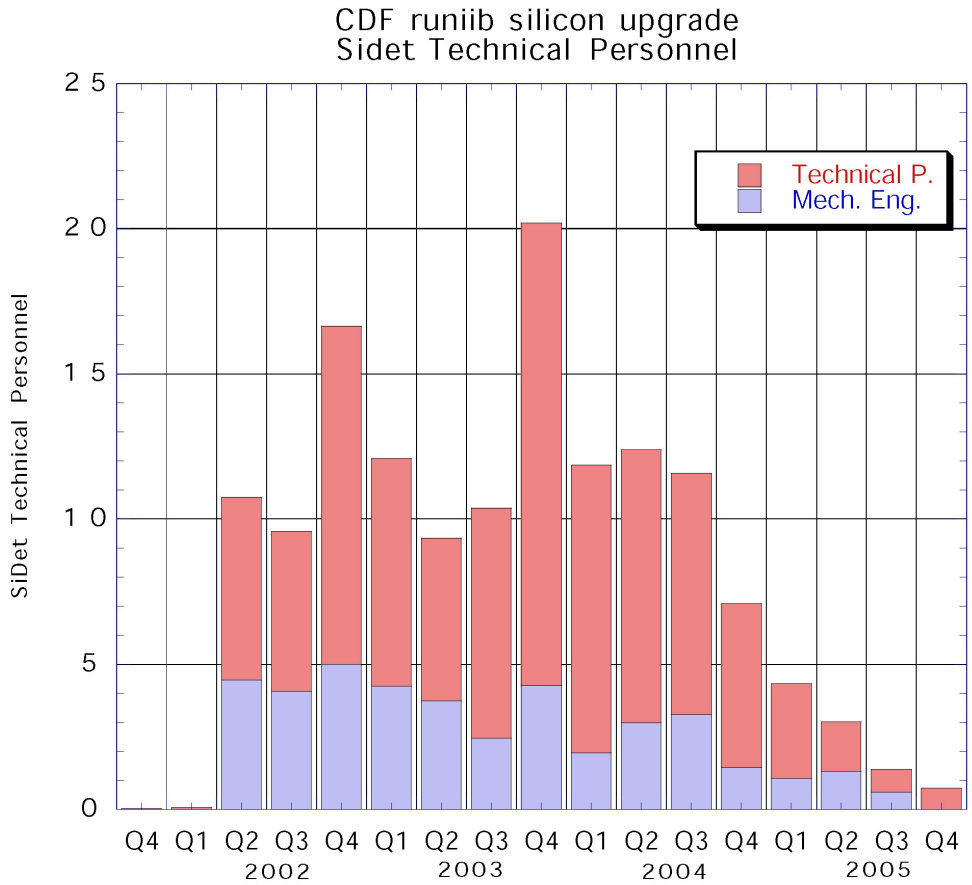
- Establish the number of hours needed to accomplish the task
- Considering 6 working hours/day
  - Impact on the total amount of time needed to accomplish the task
- An inefficiency factor of 0.73 (364 working hr./QRT.) used to determine the number of FTE needed.
- Apply a real calendar with all lab holidays

Contingency on Labor:

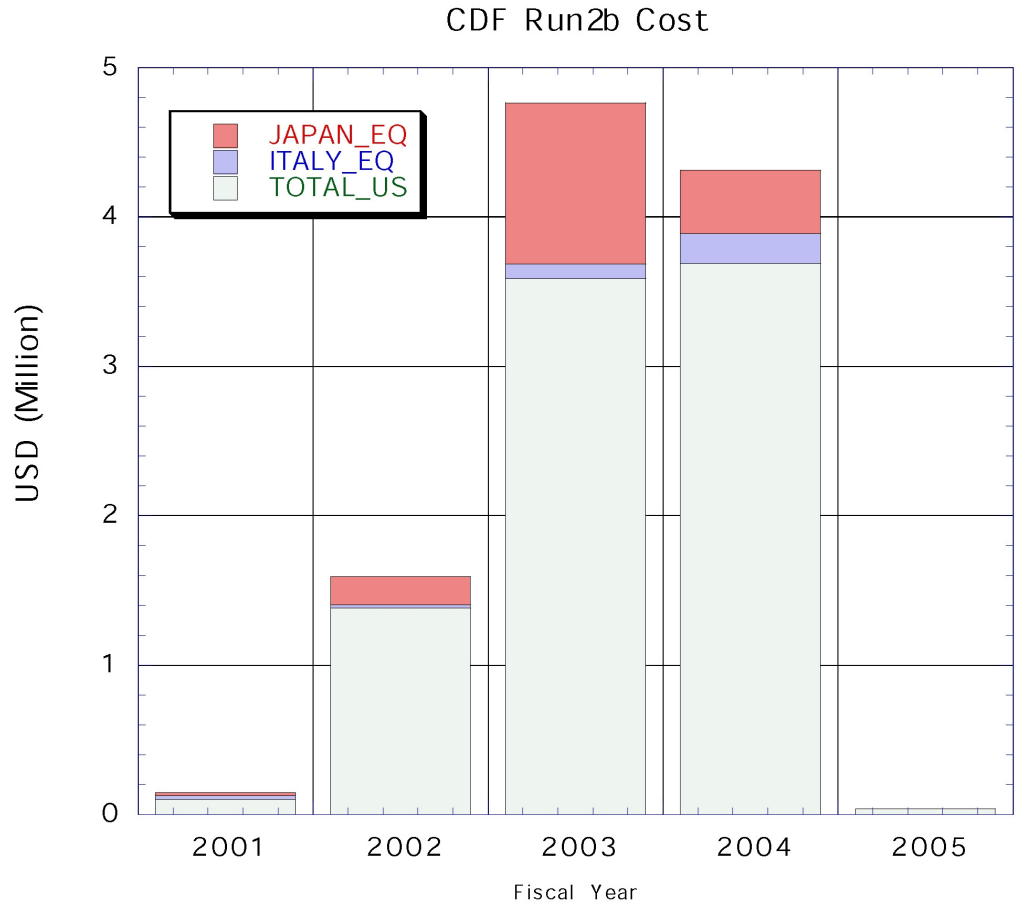
- We budgeted 0.25M$ to cover overtime and additional labor expenses

Schedule Risks

- A working SVX4 chip as soon as possible is crucial to the project:
  Reliability and ease of operation of the chip also fundamental
- Proving the electrical stave concept soon is critical
- Addressing L0 technical issues soon is critical
- Bonding time and equipment is reasonable if no too much re-work needed
  It is critical that the amount of re-work stays at a reasonable level (<15-20%)
- Stave installation/testing needs to keep pace with stave construction
- The installation period (shut down) is also critical:
  Many things have to happen in parallel and efficiently
  Work to be performed both at SiDet and in the Collision Hall
  Need to minimize the time required for connecting and testing the detector in the Collision Hall !



- SiDet Technical personnel required

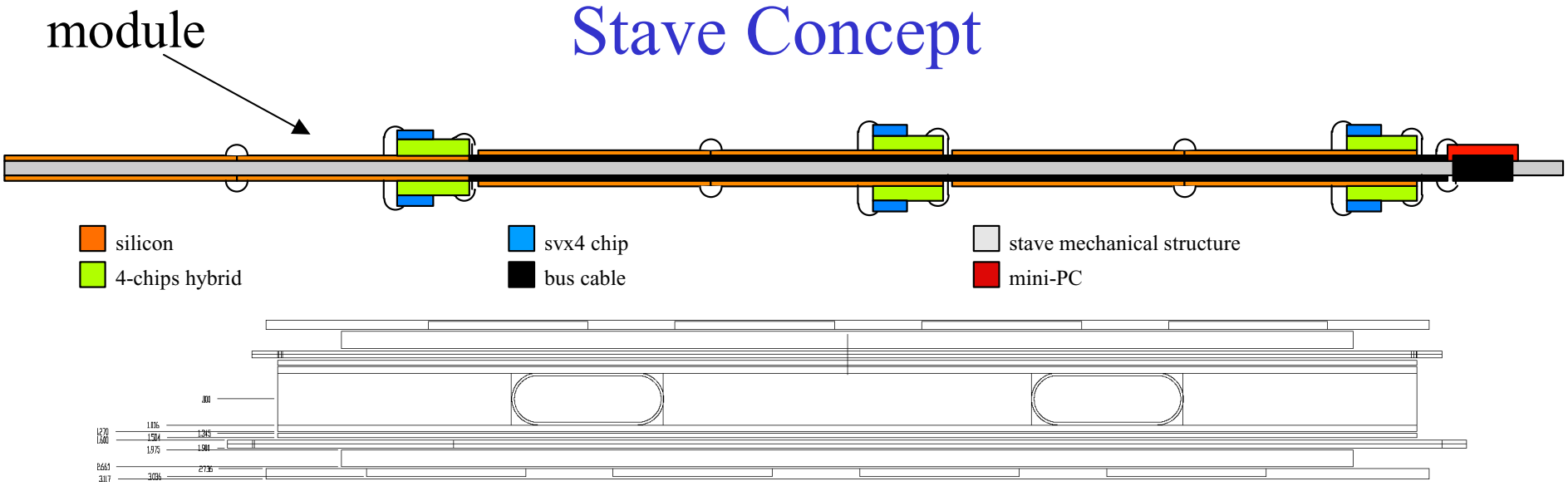


•Silicon Project cost including contingency and foreign contributions

Conclusions

- Labor needed is similar to what was used for svxiia
- We have a well established set of milestones
- We have submitted all parts needed to have a working electrical stave matching the SVX4 chip schedule.
- First stave electrical prototype available by August 2002.

Stave Concept



- The stave mechanical structure is a sandwich of carbon fiber and foam
- It has an integrated cooling channel formed by peek tubing (in/out)
- A bus cable carries all electrical/power distribution to the hybrids and silicon sensors
- At the end of the bus cable the mini port card controls all signals to and from the hybrids
- The whole detector is now made out of one single type of stave
- We have the flexibility of populating the stave with either axial or stereo sensors